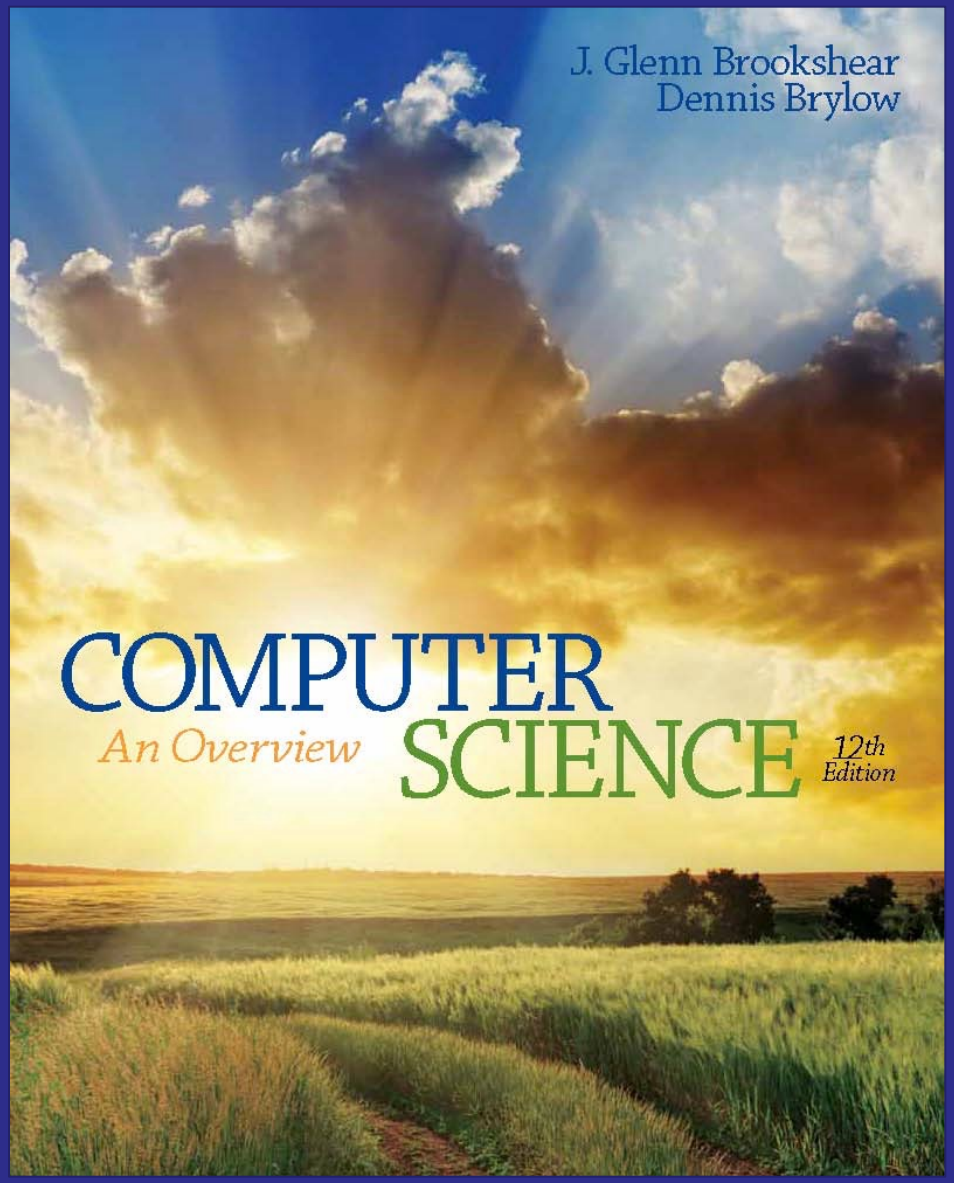
Chapter 0: Introduction



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Chapter 0: Introduction

- 0.1 The Role of Algorithms
- 0.2 The History of Computing
- 0.3 An Outline of Our Study
- 0.4 The Overarching Themes of Computer Science
  - Algorithms
  - Abstraction
  - Creativity
  - Data
  - Programming
  - Internet
  - Impact

Terminology

- **Algorithm:** A set of steps that defines how a task is performed
- **Program:** A representation of an algorithm
- **Programming:** The process of developing a program
- **Software:** Programs and algorithms
- **Hardware:** Equipment / Machinery

History of Algorithms

- The study of algorithms was originally a subject in mathematics.
- Early examples of algorithms
  - Long division algorithm
  - Euclidean Algorithm
- **Gödel's Incompleteness Theorem**: Some problems cannot be solved by algorithms.

Figure 0.2 **The Euclidean algorithm**

Description: This algorithm assumes that its input consists of two positive integers and proceeds to compute the greatest common divisor of these two values.

Procedure:

Step 1. Assign M and N the value of the larger and smaller of the two input values, respectively.

Step 2. Divide M by N, and call the remainder R.

Step 3. If R is not 0, then assign M the value of N, assign N the value of R, and return to step 2; otherwise, the greatest common divisor is the value currently assigned to N.

Outline of Our Study

- Chapter 1: Data Storage
- Chapter 2: Data Manipulation
- Chapter 3: Operating Systems
- Chapter 4: Networks and the Internet
- Chapter 5: Algorithms
- Chapter 6: Programming Languages

Outline of Our Study (continued)

- Chapter 7: Software Engineering
- Chapter 8: Data Abstractions
- Chapter 9: Database Systems
- Chapter 10: Computer Graphics
- Chapter 11: Artificial Intelligence
- Chapter 12: Theory of Computation

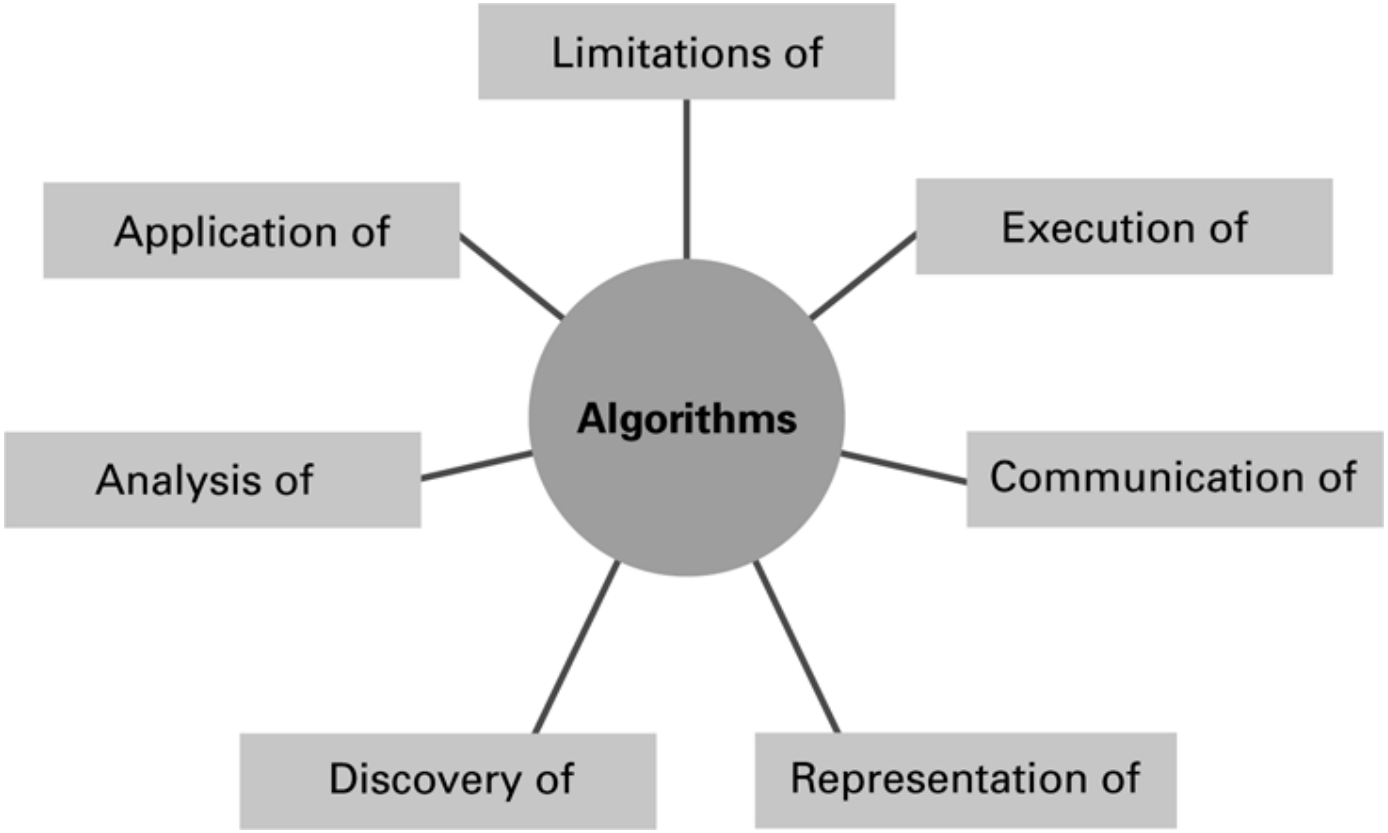
The Overarching Themes of Computer Science

- Computing technology effects:
  - Governments, economics, scientific research, role of data, communication, …
- Seven “Big Ideas” that unite computer science:
  - Algorithms, Abstraction, Creativity, Data, Programing, Internet and Impact

Algorithms

- The science of algorithms
- Draws from other subjects, including
  - Mathematics
  - Engineering
  - Psychology
  - Business Administration
  - Psychology

Figure 0.5 The central role of algorithms in computer science



Given the Central Role of Algorithms

- Which problems can be solved by algorithmic processes?
- How can algorithm discovery be made easier?
- How can techniques of representing and communicating algorithms be improved?
- How can characteristics of different algorithms be analyzed and compared?

Given the Central Role of Algorithms (continued)

- How can algorithms be used to manipulate information?
- How can algorithms be applied to produce intelligent behavior?
- How does the application of algorithms affect society?

Abstraction

- **Abstraction:** The distinction between the external properties of an entity and the details of the entity's internal composition
- **Abstract tool:** A "component" that can be used without concern for the component's internal properties

Creativity

- Computer science is inherently creative
  - Discovering and applying algorithms is a human activity
  - Extends forms of expression in many ways
- Creating large software systems is like conceiving a grand new sculpture

Data

- Computers can represent any information
  - That can be discretized and digitized
- Algorithms process and transform data
- Massive storage capacities
- High speed networks
- Interesting
  - https://bernardmarr.com/how-much-data-is-there-in-the-world/
  - https://theconversation.com/the-worlds-data-explained-how-much-were-producing-and-where-its-all-stored-159964

Questions about Data

- How do computers store data about common digital artifacts?
  - Numbers, text, images, sounds, and video
- How do computers approximate data about analog artifacts in the real world?
- How do computers detect and prevent errors in data?
- What are the ramifications or an ever-growing and interconnected universe of digital data?

Programming

- **Programming** is broadly referred to as:
  - Translating human intentions into executable algorithms
- Computer hardware is capable of only simple algorithmic steps
- Abstractions in a **programming language** allow humans to reason and encode solutions to complex problems

Questions about Programming

- How are programs built?
- What kind of errors can occur in programs?
- How are errors in programs found and repaired?
- What are the effects of errors in modern programs?
- How are programs documented and evaluated?

Internet

- Profound impact in the way information is:
  - Stored
  - Retrieved
  - Shared
- Privacy
- Security

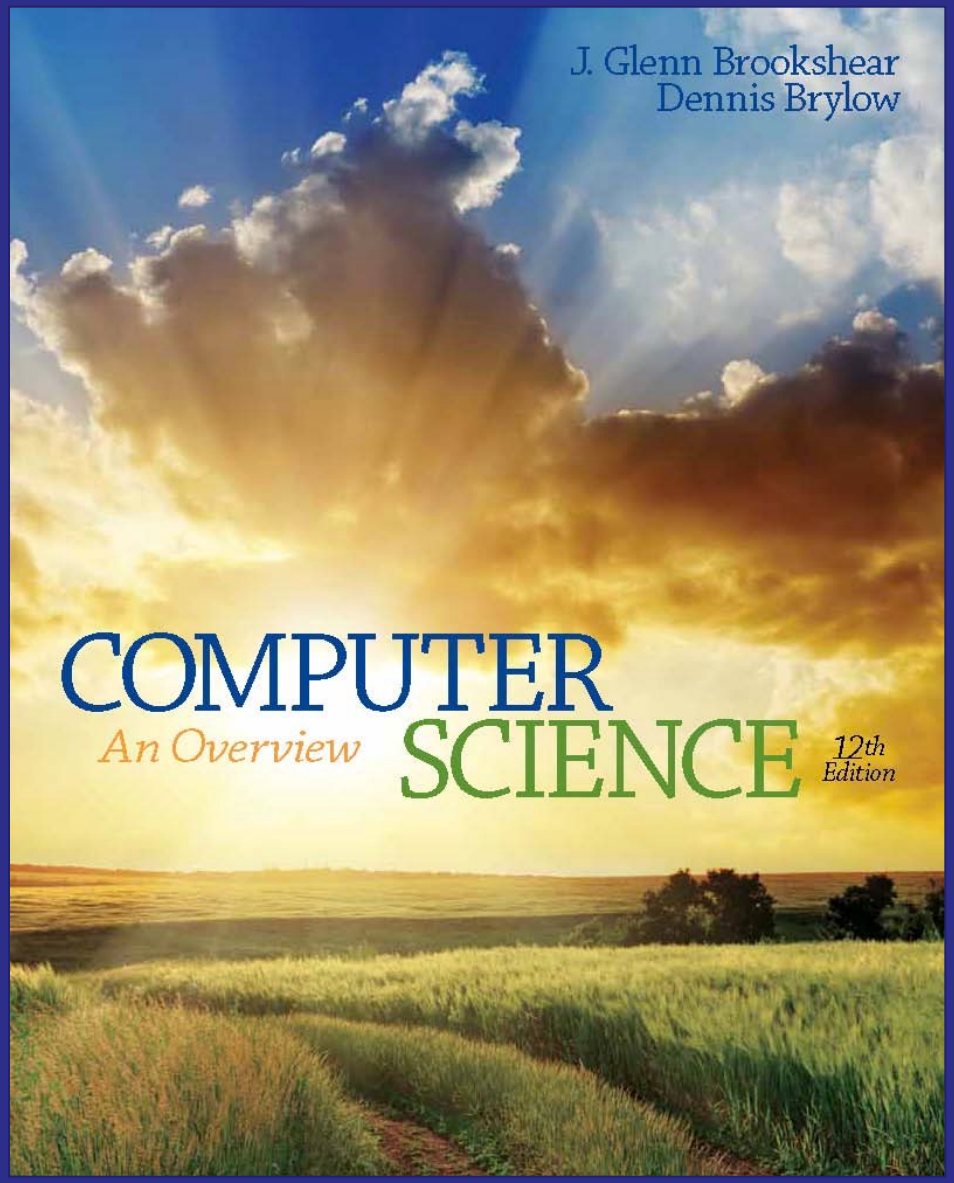
Impact

- Social, ethical, legal impacts including:
  - Security concerns
  - Issues of software ownership and liabilities
  - Social impact of database technology
  - Consequences of artificial intelligence

Impact

- No “Correct” answers, instead increase awareness of:
  - Various stakeholders
  - Alternatives
  - Short term and long term consequences
- Character-based ethics
  - “Good Behavior” is a consequence of “Good Character”

End of Chapter



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